An Ambient Air Scanning Tunneling Microscope to Study the Surfaces of Thin Metal Films

Joshua Wilson, Brandon Hoffman. Department of Physics, Houghton College, One Willard Ave, Houghton, NY 14744

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Theory

Quantum Tunneling Through an Energy Barrier

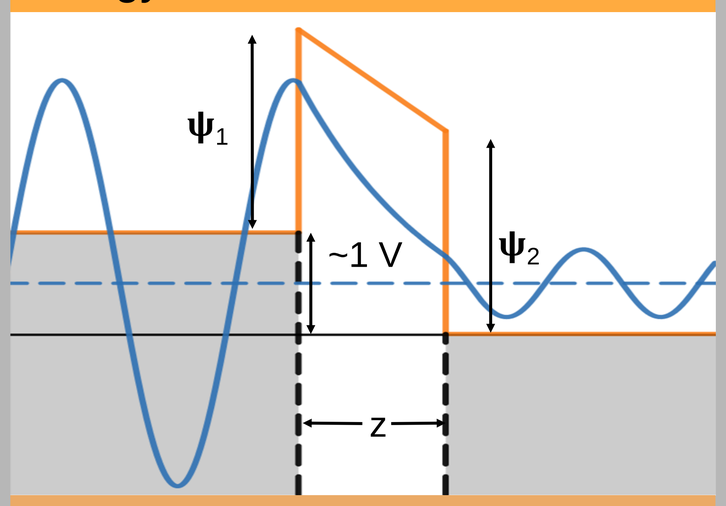

Figure 1. The probability of an electron tunneling through the barrier increases as the barrier width, z, decreases.

Tunneling Current vs Tunneling Distance

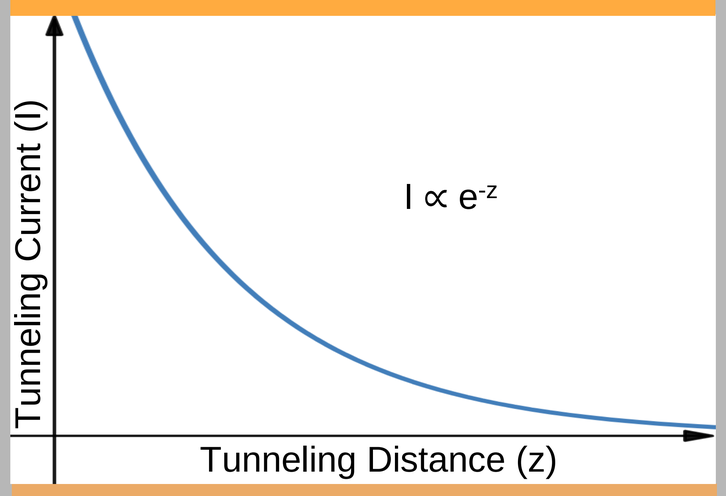

Figure 2. The tunneling current decreases exponentially with tunneling distance.

Quantum Tunneling Current

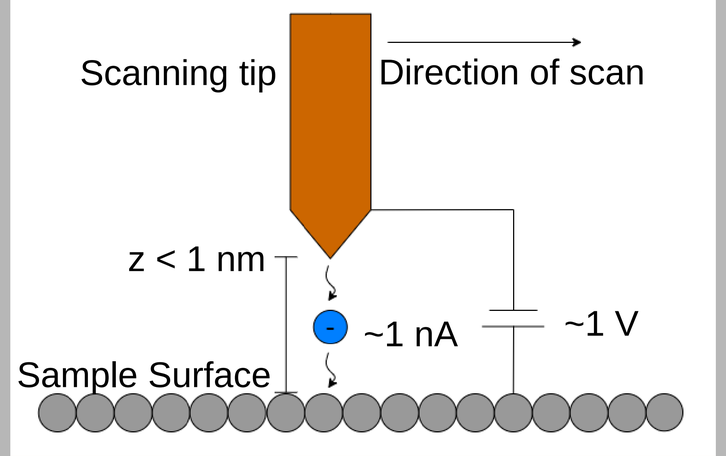

Figure 3. The current is held constant by adjusting z. The plot of the tip height is an atomic resolution image of the sample surface.

Acknowledgements
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Background Image: *Guillaume Baffou, Image de microscopie à effet tunnel réalisée au lppm à Orsay, September 2005.*

Design

Scanning Tip Controlled by Piezo

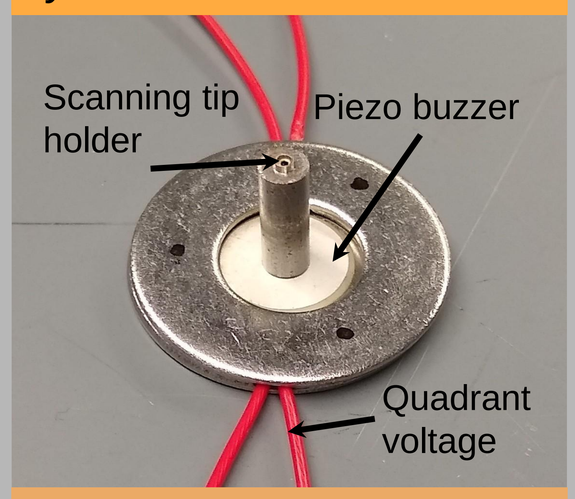

Figure 4. The tip moves in 3 dimensions when voltage is applied to the piezo.

Piezo Buzzer Tip Positioner

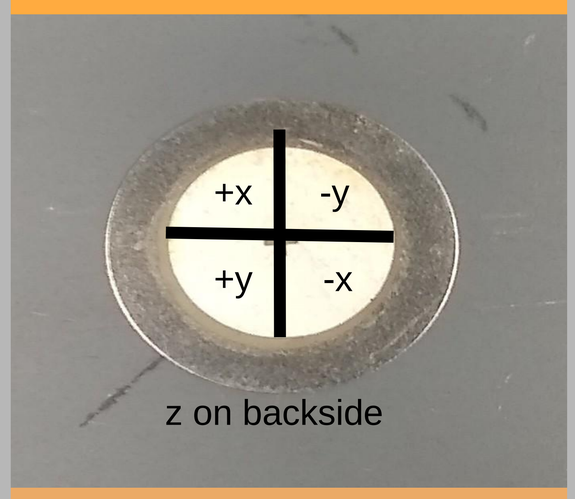

Figure 5. The leads of the piezo buzzer are divided into quadrants. 5 voltages control 3D movement.

Scanning Head and Sample Stage

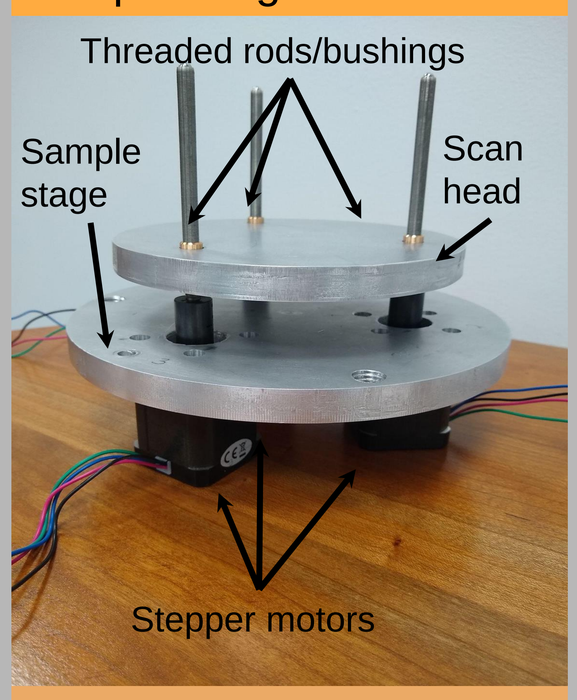

Figure 6. The scan tip is mounted on the bottom of the scan head. The motors are used for automatic approach.

Dual-Stage Isolation Frame

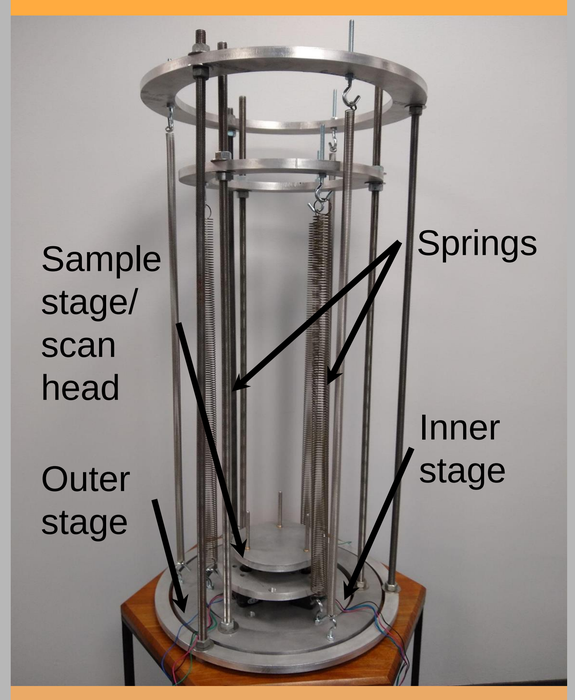

Figure 7. The frame utilizes springs and eddy current dampening to reduce vibrational noise.

Control Circuit

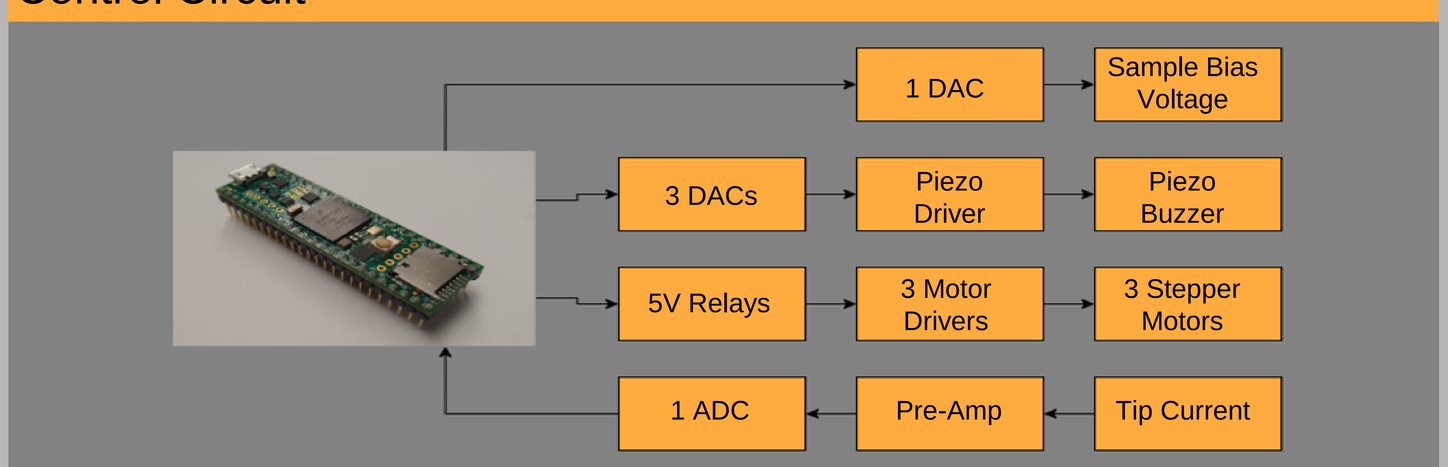

Figure 8. The 3 DACs will each send voltage to the piezo buzzer to control a different dimension of movement. The motor drivers will control the scan tip's rough approach to the sample. The current from the scan tip is sent through a pre-amp and an ADC for the Teensy to read. The Teensy will control all of this through the Processing interface.